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IBM® ^

pSeries Solution Series for e-business  
Lotus® Domino™ Server R5  
Implementation Guide

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### Disclaimer:

This solution was created and tested under laboratory conditions. Although all material is correct at date of creation, production environments may require additional steps, configurations, and performance analysis. The material herein is provided on a best-effort basis and the certification of the solution rests on the implementation team. This information is intended to guide the implementation team with initial findings for IBM **@server** Solution Series for e-business - Lotus Domino Server R5. This guide has no implied warranty nor guarantee. The users of this guide should always check the latest release information in the product Readme file(s) and check the product Web pages for the latest updates and findings.

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## pSeries Lotus Domino Server e-business Solution Overview

Domino™, a server-based product from Lotus® Corporation of IBM®, is positioned in the e-business™ marketplace as a messaging/groupware system with dynamic application serving. Domino's integrated application services, such as security, workflow and content management, optimize the platform for rapid delivery of Web applications, along with built-in connection services that provide live access to relational databases, transaction systems and ERP applications. By using Internet standards, Domino avails itself to browser clients and Internet protocols, as opposed to proprietary clients and protocols.

The Domino R5 family of servers delivers messaging, applications, and online collaboration fast and reliably for organizations from small businesses to the largest enterprises. Domino R5 helps reduce costs by making the server easier to administer and the desktop easier to manage.

First and foremost, Lotus Domino is a messaging system. It contains E-mail creation and delivery capabilities along with directories of people and objects with multiple levels of security from encryption to ACLs. Domino offers the industry's most comprehensive support for Internet messaging standards, with Internet addressing, SMTP routing and MIME content support, plus full support for E/SMTP, S/MIME, SSL, POP3, IMAP4, LDAP, HTTP, HTML, and SNMP.

The directory function of Domino contains names, addresses, and distribution lists. High-speed lookup capabilities utilize compressed directories that can be stored on local client disks. Most of the advanced functions of E-mail are included in Domino, such as encryption, tracing, format translations, attachments, and logging.

Domino contains a full calendaring and scheduling function that provides free-time searches, sending of meeting notices, time zone support, Internet access, security, and attachment capabilities. Migration aids are available to migrate non-Domino calendars to the Domino server.

Workflow is a rules-based "development" capability that combines programming logic (using templates) with mail and directory information. This allows companies to achieve efficiencies in applications such as travel expense approval, document reviews, and selective distribution of information.

Another element of collaboration is the sharing of data and documents. Domino contains a database where all information of any object type is stored. Data in the database can be assigned various levels of sharing from "none", to password-controlled, to group-controlled, to author-controlled, to encrypted, to full access to everyone. The level of control is defined by either the administrators or authors of the document. With the ability to share data, Domino provides workgroup efficiency.

If a complete document management system is needed, Lotus offers an extension product called Domino.Doc™. Domino.Doc uses a familiar library metaphor of file rooms, file cabinets, and binders. It supports complete document life-cycle management from authoring through review, approval, distribution and archiving. Domino.Doc also provides version control and check in/check out capabilities.

To support overall system performance, Domino provides a database facility called *replication*. Using replication, multiple servers and/or clients can have a copy of the database that "copies" itself whenever any item in the database changes, or it can be "copied" at defined intervals, or on demand. Having local copies that are always up-to-date provides better access time, allowing clients to work in standalone mode.

Domino creates applications with data and logic, stores them in the Domino database, and provides dynamic translation to users so that they can run the applications from either a browser or a Lotus Notes client interface. Domino's application development tools support the use of wizards, templates, C++, or Java™.

Applications can range from simple views of data with update capabilities, such as providing catalog information, to sophisticated applications such as inventory management, billing, and process models. Domino's tools and programming interfaces allow for searching, access, and inclusion of data in enterprise relational databases such as DB2® Universal Database and Oracle®. The possibilities are further extended through the use of Domino Connectors and Lotus extension products available on AIX such as Lotus Enterprise Integrator (LEI), Lotus Domino Workflow, and Lotus Enterprise Solution Builder.

Domino is a generic name for a family of server products: **Domino Mail Server** for mail, groupware, calendaring and Internet support functions; **Domino Application Server** for mail plus application development capabilities; and **Domino Enterprise Server** which adds partitioning, clustering, and usage tracking capabilities on top of Domino Application Server.

Domino supports a wide variety of popular clients, including Lotus Notes clients as well as Web browsers, Microsoft Outlook®, and mail clients based on Internet standards such as POP3 and IMAP4. Full function Notes R5 clients for messaging and/or collaboration run on Windows® 95, 98, 2000, and Windows NT® 4.0 workstations, as well as Macintosh® computers running Mac OS 9.

The latest release of Domino is R5 and contains the following advancements over Domino R4:

1. Native Internet format for mail including SMTP and MIME
2. Built-in upgrade tools for migration from applications such as cc:Mail and Microsoft® Exchange
3. Wide choice of supported clients such as Notes clients, browsers, Eudora®, and Outlook
4. Built-in connectivity for live access to relational databases and transaction systems
5. New simplified deployment and administration tools
6. Choice of Internet authoring tools for HTML, JAVA, IDE's, and scripting
7. Improved failover supporting browsers, as well as Notes clients
8. Dynamic load balancing
9. Improved capacity of directories with corresponding improvement for mobile users
10. Higher performance due to database redesign
11. Optimized to AIX® for improved capacity and response time

## Supported Software Releases

Domino Server R5 is supported on the following versions of AIX:

Domino Release	AIX Release
Domino Server R5	4.3.1
	4.3.2
	4.3.3

## PTF Matrix

In order to install Domino Server R5 on AIX, certain program temporary fixes (PTFs) are required or specific authorized program analysis reports (APARs) should be read. The following table lists the patch requirements:

Component	Recommended Level
Bos.mp	4.3.3.28
Bos.up	4.3.3.28
Bos.rte.aio	4.3.3.26
Bos.rte.libc	4.3.3.27
Bos.rte.libpthreads	4.3.3.27
Bos.rte.commands	4.3.3.26
Bos.rte.control	4.3.3.26
Bos.rte.tty	4.3.3.27
Bos.rte.net	4.3.3.2
Bos.rte.cron	4.3.3.1
Bos.net.tcp.client	4.3.3.28
Bos.net.tcp.server	4.3.3.27
Bos.net.tcp.smit	4.3.3.25
Bos.sysmgt.smit	4.3.3.25
Bos.sysmgt.trace	4.3.3.26
Bos.sysmgt.serv_aid	4.3.3.26
Bos.adt.debug	4.3.3.26
Bos.adt.prof	4.3.3.27
Bos.adt.include	4.3.3.27
Bos.adt.samples	4.3.3.25
Bos.adt.syscalls	4.3.3.25
Bos.diag.com	4.3.3.26
Bos.diag.rte	4.3.3.26
Bos.diag.util	4.3.3.27
XIC.rte	4.0.2.0
XIC.aix43.rte	4.0.2.2
Needed to prevent crashing of server when running NSD	IY06473
Prevents a problem where client connections are never released	IY11972
Maintenance level 8 (APAR IY10778) and microcode MM1032 required to enable HMT	4.3.3.50

## Performance Guidelines

**Disclaimer: Performance of applications can only be made in a general sense. Specific characteristics of application implementation on specific hardware will yield different performance characteristics. Performance tools for measurement and tuning exist in most instances and should be used.**

The Domino Server Family has had success in the market due in part to the functionality it provides for messaging, groupware, and Web application development. Because these advanced and varied sets of capabilities are integrated into one platform, measuring the performance of the Domino Server and providing recommendations for specific customer environments always proves a challenge.

### A. What Affects Application Responsiveness?

In today's distributed client/server environments, the elements that affect your customers' experience of application responsiveness are highly variable. A sophisticated application deployment tool and messaging platform like Lotus Domino has many factors that can impact its performance:

- Number of users
- User tasks and workload mix
- Access to back-end relational databases
- Static versus dynamic Web pages
- Robust graphical displays based on Java and ActiveX
- Client type (simple browser, advanced unified clients like Active Desktop, Lotus Notes™)
- Use of mail hubs
- RS/6000® configuration
- Network protocol and access methods
- Server deployment topology

### Network Protocols and Topology

Your network protocols also have an impact on your network's performance. TCP/IP has historically proven to provide the best performance and most efficient use of network adapter hardware for Notes and Domino environments. We highly recommend that you use TCP/IP on your LAN if possible, especially when implementing a geographically dispersed network that utilizes WAN links. This is because most routers use TCP/IP to communicate over WAN links, so using it on the LAN reduces processing overhead.

The partitioning and clustering features of the Domino for AIX Enterprise Server do not support the IPX/SPX protocol. In addition, support for the maximum number of client sessions can only be accomplished with TCP/IP. SPX and SPX II protocol support is intended for migration from the IPX/SPX environment

### Network Topology

Your Domino infrastructure's overall scalability depends in part on how much traffic your network can route and process efficiently. For example, if you initially deploy a few servers in a peer-to-peer topology, you may need to switch to a hub-and-spoke configuration as you add servers.

In an existing, large-scale deployment, make sure that your hub servers aren't overloaded. Check whether configuring servers-by-function for mail and replication would make sense. Ultimately, you may be able to significantly boost mail throughput and application server bandwidth by upgrading just a few servers.

## Other Workload Factors

Other factors that can impact the actual load that a given user community places on a Domino server include:

- The extra overhead associated with a significant number of dial-up connections, such as mobile employees getting E-mail or suppliers accessing a supply chain automation application.
- The extent to which applications access back-end data like relational databases and transaction monitor systems. As you might expect, the greater the number of network layers and connections involved, the greater the overhead.
- The design of your applications. For guidelines on how to design efficient Web and intranet applications, see the Lotus white paper *Maximizing Application and Server Performance in Domino* (January, 1999).

## B. Steps to Maximum Domino Performance

Performance monitoring and analysis tells you whether a server is up to the strain you're putting on it, or whether it's cracking under pressure. It can also help you find the limiting factor in a server configuration, as well as a bottleneck elsewhere in your network.

Monitoring and analyzing server performance is not easy. It can seem like more trouble than it's worth at times. But there simply is no substitute for it; in the long run, it will save you far more time and money than it costs. And you'll improve your network's efficiency and reliability in the bargain.

One key piece of advice transcends all others: Keep a "holistic" perspective on the process. Likely pitfalls in performance analysis are:

- Basing your analysis on a single performance metric.
- Looking for a single step that will solve all your problems. Factors that impact performance are interrelated. So there's almost always more than one move you'll need to make.
- Making across-the-board decisions or recommendations. Each server or platform has unique workload characteristics, related to the databases on the server and what users are doing with them. These differences can be important.

## Know the Configuration

Domino administrators should know the configuration of the servers they're supporting. The main components of any server are memory, CPU, and disk (both logical and physical). Things like onboard cache memory and the number of disk controllers are also important.

Here are additional tips that may help you find configuration-related problems faster:

- Use the fastest disks you can find (10,000 RPMs).
- Use hardware RAID over software RAID; it's faster and there's less CPU overhead.
- Processor speed is important for indexing.
- An adequate disk subsystem means lower memory requirements because fewer temporary I/O buffers are cluttering up your RAM.
- Beware of standard server configurations; they are not optimal for Domino servers. The most important thing missing is typically adequate disks and controllers. See your hardware vendor's NotesBench® data for guidelines. (In other words, configure your systems like the folks who ran the NotesBench tests configured theirs.) For more information, visit <http://www.notesbench.org> (registration required).



## Distribute I/O Across Physical Disks

Our experience has shown that physical and logical disk structures are our customers' least understood system resource, and the one most often undersized. The best way to boost performance on many Domino servers is to distribute I/O across separate physical disk subsystems.

Ideally, you want to put the following I/O-intensive files on separate physical disks:

- The Notes paging file
- Your .NSF files
- The Domino R5 transaction log

If you can put them on separate controllers, too, so much the better. The idea is to increase I/O throughput by distributing the work over busses, controllers, ports, and disks. Hence, several small physical disks are better than a few large-capacity disks. In particular, the more you isolate the R5 transaction log from other disk activity, the better your server performance will be.

## Log Performance Metrics Consistently

If you don't log performance metrics, you won't be able to quantify the success or failure of your tuning efforts. If you do keep logs, you'll not only have a far better idea of what you're doing, you'll have a far easier time documenting the need for additional expenditures.

Among the key metrics to track are:

- Total CPU utilization (expressed as a percentage). If this metric is above 70% to 80%, that's a red flag.
- Disk queue length (typically this should be less than 2 items in the queue) and average disk service time (should be less than 70%).
- Paging file size and utilization. Utilization should be fairly low, or it's probably worth it to buy more memory.
- Domino statistics and events for mail throughput, replication, Web server activity, and database activity.
- Domino logs (*log.nsf*); they're boring but they often come in handy.

It's important to collect production data weekly, and analyze it monthly if possible. It's also critical to capture "snapshots" of performance before and after major configuration changes.

For AIX systems, there is a Notes Agent for Performance Toolbox (PTX) that will monitor and report on Domino Performance.

## Optimize for Domino R5

Domino R5 does a great job auto-configuring and dynamically reconfiguring key parameters for maximum performance. Here are some tips from the experts on how to tune the Domino R5 server itself:

- Set up the correct number of mailboxes. Multiple *mail.box* files reduce contention for mail deposits and other mail-related activity. The biggest performance gains come when you add a second mailbox. The rule of thumb we use is one mailbox for 1-200 users supported, two or more for 200-1,000 and ten (the maximum) for 1,000 or more users.
- For non-partitioned systems, let Domino dynamically set *NSF\_Buffer\_Pool\_Size*. This is particularly important in low memory server configurations, where a large buffer pool can interfere with the kernel's memory management.

- For partitioned systems, you will need to ensure the NSF Buffer Pool is properly set since Domino cannot automatically determine the memory that's actually available to it across multiple partitions. This can be accomplished by placing the following variable in the *notes.ini* file:

`PercentAvailSysResources=nn` (where *nn* is 100 / number of partitions)

- Let Domino allocate mail delivery threads (for local delivery) as needed, based on available memory.
- Let the Domino router allocate the mail transfer threads (for delivery to another server), based on demand.

Configured appropriately, a Domino R5 server running on AIX can transfer 20,000 messages in one minute.

### Make Use of NotesBench Data

Most benchmarks just tell you what vendors want you to hear. But NotesBench really is different. NotesBench benchmarks enable you to make "apples to apples" comparisons about Domino capacity on hardware configurations from various vendors. You can even guesstimate total cost of ownership with reasonable accuracy using these numbers.

Perusing NotesBench data is also a great way to glean information on how to optimize your system configurations. Check out what disk topology, kernel settings, patches, and service packs were used (and not used) to squeeze maximum performance from their systems.

### Learn from Semaphores

Semaphores are a communication mechanism used among process threads. Here is a list of popular semaphores and what they mean from the standpoint of performance:

- Collection (0x30B) and Collection Queue (0x309). Indicates that the CPU and memory are bottlenecked. Best fix is to defer Administration Process activities to non-peak hours and optimize the I/O subsystem.
- DB (0x245) and DB Queue (0x244). Indicates that the database cache and disk I/O are bottlenecked. Best fix is to add more memory and optimize the I/O subsystem. Enabling field-level replication (if you haven't already) will also help.
- BTree (0x255). Indicates a problem with how views are stored and rebuilt. The best fix is to defer view rebuilding to off-hours, and optimize the I/O subsystem.

### Know the Symptoms of Server Over-Utilization

Typical problems that point to a server that's in over its head are slow or failure-prone mail delivery, degrading user response time, and slow address lookups.

To check mail delivery, look at the percentage of time your disks are utilized, and at mail queue length. For R5, you can also check (and optimize) the number of mail.box files and the numbers of transfer and local delivery threads.

To enhance response times, try optimizing the manner in which I/O-intensive files are distributed across the disk subsystem.

If address lookups are slow, things may improve substantially when users deploy Lightweight Directories on their desktops. This will reduce the load on the server and the network. You can also check the hit rate for the Name Lookup Cache. A good hit rate is at least 85%.

If your problem is slow page rendering or an unresponsive Web server, check the number of HTTP threads, and the percentage of time disks are utilized. Set the number of HTTP threads at 1:10 (one thread for every ten users).

How can you tell if a server is *underutilized*? Look for a CPU utilization rate below 50%, disk access ratio below 50%, or more than 200 MB of RAM consistently available. But note that the resources required for

additional users probably won't be equivalent to the resources required for an equal number of your current users. For example, per-user memory requirements decrease as the number of users increases, because fixed memory overhead is divided across more users.

### Consider Clustering

Clustering is the premier feature of the Domino Enterprise Server. Clustering gives you dynamic load balancing, which automatically optimizes resource utilization across the cluster. Clustering also provides failover for mail and applications, including Web applications. You can cluster any combination of R4 and R5 servers, across any mix of supported Domino platforms. And you can cluster partitioned servers alongside non-partitioned servers.

### Consider Partitioning

Partitioning can improve the resource utilization of high-end Domino systems, however, it may also require additional hardware resources to properly implement transaction logging. It allows you to distribute servers by department or function while retaining the benefits of consolidation. Some organizations even use partitioning to create "service level options" (i.e., putting a few key executives on one partition and the masses on another). As a general rule, the number of partitions on a system should never exceed the number of CPUs.

### Know When to Consolidate and When to Distribute

Unless you have some compelling reason to do otherwise, choose consolidation over distribution as a growth strategy. Consolidation invariably reduces cost and improves reliability: fewer servers mean less complex server topologies, and fewer server-to-server activities: less network traffic, less replication, and less mail transmitted between servers.

When would you want to distribute servers instead of consolidating them? You may have geographic distribution requirements where dedicated servers handling local users and data are the lowest-cost solution. Or your deployment may be comparatively small but growing fast, so adding more servers to accommodate new users or distribute functions lets you leverage current investments better. IBM has developed a Red Book on this subject, entitled *IBM Servers and Lotus Domino: Centralize and Distribute Enterprise Architecture Planning*, available at <http://www.redbooks.ibm.com>.

## C. Performance and Capacity Planning Tools and Resources from Lotus

To help you appropriately plan for your deployment, Lotus provides:

- Tools and benchmarks from Lotus and RS/6000 that enable you to monitor, manage, and optimize Domino Server performance.
- Support resources that help you address the performance in your environment.
- Knowledge transfer in the form of course packs and online resources to help you understand the issues involved.
- Domino Performance, Capacity Planning, and High Availability Web site that provides current detailed information about performance and capacity planning, tools, hardware benchmarks, white papers, and interactive discussion forums. Visit <http://www.lotus.com/performance> for more information.

### Lotus NotesBench

Lotus and RS/6000 use NotesBench, a standard benchmark for Domino, to generate and provide performance information. NotesBench uses standardized workloads with a strict testing protocol on various Domino/Notes platforms and configurations.

Customers can, in turn, use the benchmark information while evaluating RS/6000 and pSeries models, selecting configurations, and planning against resource budgets. Business Partners who are members of the NotesBench Consortium, and have been trained in the use of NotesBench tools can create

specialized benchmarks that are unique to a customer's deployment. This allows Business Partners to assess specific server environments and compare it with various RS/6000 models and configurations.

An independent agency audits and published NotesBench reports. For the latest information and NotesBench reports, see <http://www.notesbench.org> or <http://ideasinternational.com>.

The NotesBench Mail workload models an active user reading and sending mail, along with the additional functions of user lookup, creating a meeting invitation (every 90 minutes), etc. Overall, the workload is still seen as very light.

As a rule of thumb, if you divide the NotesBench users attained by 3 or 4 or 5 you may be close to an approximate number of "real" users. If calendar functions are used, up to an additional 25% reduction in the number of "real" users is a good rule of thumb.

### NotesBench Metrics

Lotus NotesBench is a collection of benchmarks, or workloads, for evaluating the performance of Domino servers. Of particular interest are:

- **Maximum users supported:** The maximum number of concurrent workload threads connected to the server during the simulation.
- **NotesMark:** A throughput metric, which measures performance in terms of the cumulative number of Notes transactions per minute (tpm) performed by all the threads in the test. Note that tpms do not correspond 1-to-1 to Notes operations; opening a database, for example, is one transaction from a real user's perspective, but may constitute two or three transactions from the viewpoint of NotesMark.

The following mail workload scenarios were driven by an automated environment which ran a script similar to the mail workload from Lotus NotesBench. Some of the results shown here are not official NotesBench measurements or results and are noted as such. Unofficial numbers may not be used officially or publicly to compare to NotesBench results published for other Notes server environments. For official audited NotesBench results, see <http://www.notesbench.org>. (Note: In order to access the NotesBench results, you will need to apply for a userid and password through the NotesBench organization.)

Model	NotesBench Mail Users	NotesMark (transactions per minute)	\$/NotesBench User	\$/NotesMark	Domino Release
RS/6000 Enterprise Server M80 8-way, 4 partitions	28,032	38,235	\$23.91	\$17.53	5.0.3
RS/6000 Enterprise Server F80 6-way, 2 partitions	17,400	23,973	\$19.61	\$14.23	5.0.3
RS/6000 Enterprise Server S80 24-way, 24 partitions	57,600	71,904	\$27.51	\$22.04	5.0.2
pSeries 640 - B80 4-way, 7 partitions <sup>(1)</sup>	13,500	18,583	\$24.83	\$18.04	5.0.3
pSeries 680 - S85 24-way, 30 partitions <sup>(1)</sup>	108,000	150,197	\$23.79	\$17.10	5.0.6a

1. The results are not official NotesBench measurements or results.

## Sizing Guidelines

**Disclaimer:** System sizing for applications can only be described from a general perspective. Definitive characteristics of application implementation and behavior on specific hardware will yield different sizing requirements. Use system sizing tools when available for your specific environment.

### Domino on AIX:

Several factors should be considered when determining the size of the hardware for use with Domino Server. Among these are number of users, network topology, geographic locations, and scalability. Since every installation of Domino Server is different, there is no way to give an exact measurement for determining the size of the hardware needed to support a population of users. The information provided here is a "rule of thumb" and provides a good starting point for determining the size and amount of hardware required. As with any installation, the size and amount of hardware may be greater or less depending on the actual environment.

Memory requirements are a base of 128 MB of memory and 1 MB for each connected mail user anticipated on the system.

Disk space requirements are 360 MB for the Domino Server program files (160 MB for the Domino binaries and 200 MB for the data files) + 50 MB per registered mail user + additional space for any Domino application that may be used + the paging space requirements.

A good recommendation for performance that pertains to disk access time, is to split the registered mail users into separate file systems onto separate disks. A good rule of thumb to follow is approximately 500 mail files per file system.

Processor requirements are very dependent on workloads. A recent RS/6000 Model M80 benchmark had 7008 active users per partition. There is a logical limit derived from the experience of existing customers. In discussing *active* versus *registered* users, normally we apply a 50% rule of thumb; if there are 1000 registered users in the domain, then only 500 will be active at any one time. The next level of experience has to do with the complexity and quantity of mail for the registered users. We recommend running R5 across four processors. Thus, if there are to be 1000 active users, a 4-way processor with a single partition would create the best performance. The processor group used in the prior analysis was the 332 MHz 32-bit processor. As the processor speed is higher as in the S7A and S80, then the number of active users supported can grow. As the processor speed goes down to the class of the 43P-240, then the number of supported active users goes down as well.

Single processors can support Domino, but Domino will be limited by the processor power. Domino involves many processes and many threads, of which a limited number get processor time at once. To the degree that any application scales, more processors allow greater process and thread distribution, thus getting more work done at once. This is why SMP machines provide greater throughput. For example, a 2-way system would perform better with one partition of 600 active users over two partitions of 300 users each and also the environment would not have the dual administration overhead.

Network adapter requirements are 1 adapter per 1000 users. As with the processors, there are other factors that determine the number of network adapters such as user workload, Domino partitioned servers, and network infrastructure.

## A. Domino R5 on AIX

Domino R5 was designed to provide overall performance and scalability improvements over Domino R4. The table below illustrates the general magnitude of R5's scalability increase by client type:

Client Type	R5 Scalability Increase
Lotus Notes®	300%
POP3	400%
IMAP	500%
Web Mail	1,500% on UNIX
NRPC (UNIX)	500%

The above enhanced performance is due to the following changes made in Domino R5:

- Optimization of the database format (the On Disk Structure or ODS) to minimize I/O contention. With R5, writes to disk are fewer and more efficient.
- Transaction logging. In R5, database operations are recorded sequentially, not all over the disk. This reduces I/O activity levels while increasing data integrity and dramatically speeding up server re-start.
- Multiple server mailboxes. On a Domino R5 server, messages can be deposited into any one of multiple mailboxes. This reduces both user and router contention for mail deposits and other mail-related activity.
- Pooling of threads relating to end-user sessions. In R5, one thread can handle sessions for thousands of users. In R4, each user session required a separate thread, and a complete memory structure to go along with it. Fewer threads and processes equals lower overhead and more available memory and CPU cycles.
- Better memory management, through the Unified Buffer Manager (UBM). Among other things, the UBM dynamically manages the notorious `NSF_Buffer_Pool_Size` parameter, by monitoring the relationship between available memory and buffer sizes.
- More efficient utilization of large memory areas. If it's available on the RS/6000 configuration, Domino R5 makes more efficient use of RAM for internal caches and buffers, boosting performance compared to storing items on disk.
- A two-fold improvement in the speed of view rebuilding and incremental indexing. On servers with large numbers of databases, the processing time saved is significant.

The cumulative effect of R5 performance optimizations (those listed above, plus many others) translate into efficiency gains of these rough magnitudes:

- A 30% reduction in memory usage requirements per user
- 10-20% more efficient utilization of I/O subsystems
- 75% faster response times across a broad range of mail- and application-related activities
- Significantly less server-to-server message traffic, resulting in reduced network bandwidth requirements
- Transactional logging

While R5 performance gains are generally outstanding, they are comparatively even greater on AIX. The Domino R5 architecture is so inherently scalable that it can take full advantage of the powerful RS/6000 and pSeries computing platforms, including SMPs, gigabytes of memory and terabytes of disk.

Among the key Domino R5 features that enable it to scale with these platforms are:

- Unlimited database size (currently certified up to 64 GB), to support increased database workloads.
- Directory scalability in excess of one million users, to easily handle the directory requirements of even the largest deployments. (Lotus has tested a Domino R5 Directory with *10 million* entries)
- Database optimizations to better exploit high-end I/O and CPU throughput.
- Support for online indexing, online database compacting, and online backup; to take advantage of high-end systems and I/O subsystems.
- Increased overall scalability enabling support for more users on fewer partitions, to drive down per-user costs across large, partitioned servers.

Domino R5's ability to keep running during scheduled maintenance tasks like database compaction, indexing and backup makes server consolidation in general more attractive, since large numbers of users will not be inconvenienced due to scheduled outages.

And R5's greater scalability and new high availability features make server partitioning a more attractive alternative than ever. Partitioning yields lower total cost of ownership: administration and maintenance are simplified, and fewer moving parts increases reliability, security and availability (if one partition fails, others remain available).

### **Domino R5 on AIX Specifics**

Domino R5 on AIX leverages many platform-specific services directly. For example, R5's new thread pooling capability was optimized specifically for AIX. And Domino R5's high-availability features are particularly well-integrated and complement those of HACMP of AIX. For example, R5's transaction logging makes performance and UNIX® auto-restart features even more effective, by allowing Domino to restart very quickly.

For customers using Domino as a Web application server on AIX, R5 clustering supports both failover and load balancing for Web clients. And the Domino R5 Server's clustering features are complementary to HACMP on AIX, such as high-speed interconnects, disaster tolerance and support for many-node clusters. In fact, Domino clustering in combination with AIX-based clustering can bring system availability into the 99.99% range.

When looking to size a Domino R5 server on AIX, the basics for memory, disk, and network adapters has not changed from R4. What has changed are the scalability factors that can be applied to determine the number of partitions and the number of users per partition. As a rule of thumb, we see the scalability doubled (meaning Domino can now support up to 4 processors per partition with scalable growth as processors are added) and approximately 1.5 to 2 X the number of users per partition. Example: With R4, if we have a 4-way running two partitions of 600 users each for a total of 1200 active users, then R5 with the same 4-way could support the same 1200 active users on a single partition (hence better administration). Therefore, as a guideline:

- R4 - one partition for every two processors
- R5 - one partition for every four processors
- R4 - one partition for every 600 - 800 active users
- R5 - one partition for every 1600 - 2000 active users

If workloads are unknown or heavy, then the lower limits should be planned for and then measurements made once in production.

When clustering is used, customers have reported approximately a 20-25% overhead. If calendaring and scheduling is used, an approximate 25% overhead should be applied.

## **B. RS/6000 Domino Server Sizing Tool**

The RS/6000 Domino Server Sizing Tool is a server-sizing, capacity-planning tool used to suggest server configurations based on benchmark information and on your customer requirements. You can evaluate different server offerings with a mix of workloads that map to your internal deployment, such as mail, discussion databases, groupware, and Web users. Because you can specify expected workload, it is the best tool for recommending which RS/6000 server to purchase based on your predicted load. The sizing tool currently is based on NotesBench and capacity data on Domino R4. When Domino R5 data is available, the Sizing tool will be updated and noted on the Business Partners site. Your IBM representative can access the sizing tool and assist in sizing recommendations.



## Sample Configurations

The verification test was run on the configuration mentioned previously. Below are sample configurations for light (small), medium, and high (large) workload /user communities. These are meant to be guideline configurations relative to memory, disk, and adapters. Specific configurations should be based on customer requirements. The configurations briefly described here can be found in Appendix A.

### Small Configuration:

This RS/6000 configuration supports up to 2,700 active users of mail where the mail load is 5 times that of NotesBench. This configuration can be used for many solution examples, but if more than mail is used, the number of registered mail users would decrease dependent on the added application workload. There is an unofficial NotesBench test resulting in 13,500 users that can be used to demonstrate the performance factors of this model and support calculations to determine variations on the below configuration to support entry and growth requirements using the pSeries 640 expansion capabilities. (Note: Unofficial numbers may not be used officially or publicly to compare to NotesBench results published for other Notes server environments.) The configuration is an IBM pSeries model 640 with a 375 MHz 4-way 64-bit Power3-II processor, with 1164.8 GB disk and 8 GB memory.



### Medium Configuration:

This configuration supports up to 5,606 active users of mail where the mail load factor is 5 times that of NotesBench. This configuration can be used for many solution examples, but if more than mail is used, the number of registered mail users would decrease dependent on the added application workload. There is an official NotesBench test resulting in 28,032 users that can be used to demonstrate the performance factors of this model and support calculations to determine variations on the below configuration to support entry and growth requirements using the M80 expansion capabilities. The configuration is an IBM RS/6000 model M80 with a 500 MHz 8-way 64-bit RS64 III processor, with 1747.2 GB disk and 16 GB memory.



### Large Configuration:

This RS/6000 configuration supports up to 21,600 active users of mail where the mail load factor is 5 times that of NotesBench. This configuration can be used for many solution examples, but if more than mail is used, the number of registered mail users would decrease dependent on the added application workload. There is an unofficial NotesBench test resulting in 108,000 users that can be used to demonstrate the performance factors of this model and support calculations to determine variations on the below configuration to support entry and growth requirements using the pSeries 680 expansion capabilities. (Note: Unofficial numbers may not be used officially or publicly to compare to NotesBench results published for other Notes server environments.) The configuration is an IBM pSeries 680, 24-way 600 MHz 64-bit RS64 IV processor with 5241.6 GB disk and 96 GB memory.



## Pre-installation Support

### A. Pre-sales Technical Support

Further assistance is available to assist in overall marketing activities through Partner Line. When called, the first step will be the Business Partner entitlement. Partner Line for non-entitled Business Partners will also send the information that will enable the Business Partner to gain access. Advanced and Premiere level IBM Business Partners are eligible for Partner Line. (Member level IBM Business Partners gain pre-sales support via their distributor.) Once access is made, Business Partners can interact with a specialist from Techline Sales Support for RS/6000s, AIX, or Lotus Domino (and they should ask specifically for the e-business Team for Domino) or Business Partners can access Compete Line for information about non-IBM offerings. (There are other aspects of Partner Line which are not to be discussed here such as order tracking, payment tracking, etc.) BESTeam® members have automatic access to Partner Line.

### B. Education

Technical education is available to enable personnel who will be responsible for the implementation and administration of AIX and Domino installation.

Course Name	Course Cost	Course Duration	Course Number
AIX V4 System Administration	\$2,395.00	5 days	Q1114 (NA), AU14 (WW)
AIX V4.3 Advanced System Administration	\$2,395.00	5 days	Q1116 NA), AU16 (WW)
AIX V4 Configuring TCP/IP and Accessing the Internet	\$2,595.00	5 days	Q1107 (NA), AU07 or 05 (WW)
AIX Support Certification Test Preparation Workshop (US only)	\$1,450.00	2 days	Q1825
Apprenticeship with skilled RS/6000 technical person	\$0.00	2 weeks	n/a
Implementing Lotus Domino R5 on RS/6000 Workshop (Self Study)	\$0.00		Q923S

Technical Certifications recommended:

Certification Name	Exam Numbers (available at Sylvan Learning Centers worldwide)	Exam(s) Cost
IBM Certified Specialist - AIX System Administration (V4.3 or V4.1)	181 (V4.3) or 161 (V4.1)	170
IBM Certified Specialist - AIX Support (V4.3 or V4.1)	189 (V4.3) or 169 (V4.1)	170
IBM Certified Specialist - Domino for RS/6000	176	170

Domino product education is available worldwide from Lotus Authorized Education Centers. A full range of Domino courses from administration, to installation, to programming are available for a fee and can lead to Lotus Domino certification. For courses and schedules access the Domino homepage at <http://www.lotus.com>.

## Implementation Process Overview

The installation of Domino not only includes installing and configuring the server software, but also making sure that the network, hardware, and operating system meet certain requirements. Installation requires training and performance tuning.

This section discusses items that are important to the installation process that are usually overlooked or not normally considered as being part of the install process.

### **1. Select an Install Team**

While installing Lotus Domino Server R5 is not difficult, it is important to include representatives from all technical areas and departments involved in the installation. This allows your team to evaluate the effect of upgrading on all functional areas and to leverage the skills not only of your Information Systems (IS) department, but of other parts of your organization. At a minimum, your team should include:

- Domino Server Administrators
- Network Administrators
- Support and Help Desk Technicians
- Application Developers
- Database Managers
- Training Specialists/Educators
- End User Representatives (especially local expert and power users)

By forming the install team early in your process, you allow greater control and planning of the Domino installation, reduce concerns about the installation process, and create a commitment to the Domino installation project.

Designate one or more project leaders for the Domino installation. These leaders should be responsible for:

- Determining the business need for Domino in your organization
- Coordinating the installation schedule
- Setup and monitor installation testing
- Apprising users and management of the installation and its effect on them
- Capturing knowledge and share it through best practices
- Documenting issues encountered and their solutions
- Coordinating communication, including project databases, meetings, and conference calls

### **2. Take a Complete Inventory of Server, Network, and Workstation Equipment**

An inventory of your IT infrastructure will help you identify the elements that need to be addressed during your Domino Server implementation. These may include computer hardware and operating systems, software programs, and other equipment. Once the inventory is complete you will need to determine the areas that need attention before Domino Server and the Notes client can be installed in your environment.

You will probably want to start with a detailed inventory of the network infrastructure and all related equipment. The list below contains some items that you should include in your inventory. Since every environment is different, you may have additional equipment or items that may be pertinent to your particular environment. Be sure to include those as well.

**Network:**

- Network equipment (hubs, switches, routers, firewalls)
- Network diagram
- WAN diagram
- Bandwidth capacity

Next, you will probably want to conduct a detailed inventory of the server equipment and all related equipment. The list below contains some items that you should include in your inventory. Since every environment is different, you may have additional equipment or items that may be pertinent to your particular environment. Be sure to include them.

**Servers:**

- Operating systems
- Memory
- Disk space
- Processors
- Network adapters
- Existing applications

Finally, you will probably want to conduct a detailed inventory of the workstations and all related equipment. The list below contains some items that you should include in your inventory. Since every environment is different, you may have additional equipment or items that may be pertinent to your particular environment. Be sure to include those as well.

**Workstations:**

- Operating systems
- Memory
- Disk space
- Processor speed
- Network adapters
- Existing applications

The information collected in the inventory should be documented and used to determine if there are any areas that are weak and require an upgrade or additional equipment or software. The inventory serves as an overall picture of your entire IT infrastructure.

**3. Train Domino and Network Administrators**

Domino contains extensive features that cover mail, applications, Internet and remote access, and connectivity to other back end databases. Given the large number of features that Domino has, training is a vital part of the implementation process. Taking the necessary steps up front to ensure your support staff is knowledgeable about the Domino product will improve the effectiveness and efficiency of your installation project, and reduce the cost associated with downtime and technical support.

Domino Administrators and all support staff should understand all Domino features and functions. They should also understand how Domino will impact the network, including existing servers, existing applications, WAN communications, and end users before any installation steps are taken.

An initial training course for your staff can be created which will provide them with basic knowledge about Domino Server, the Notes client, the Administration client, proposed server topology, proposed

connectivity maps, and a list of possible errors that they or end users may encounter during the installation project and how to resolve them.

After an initial course, it is highly recommended that each administrator and support staff member receive full training on Domino R5. They should learn how to use the end user interface, administrator interface, designer interface, know what components are available, how to perform the daily functions all users perform, and how to access different features and functions. The more comfortable your support staff is with Domino, the more comfortable your end users will feel. A knowledgeable staff means a successful and efficient roll out, and less pain for everyone involved.

Education can be conducted using any of the following methods. Each method has its pluses and minuses depending on your particular environment.

- Formal Lotus training
- CBT self study course work
- Customized training from a Business Partner

#### **4. Setup a Pilot Project**

Before installing Domino in your organization, you should test the install procedures in a non-production environment where you can try things, make mistakes, and gain valuable experience. While installing Domino is straightforward, each organization will have a different infrastructure, needs, and deployment plan. By testing, you familiarize yourself and your install team with the procedures and the process of installing.

A pilot project should reproduce, on a smaller scale, the proposed Domino system for your organization. This will give your organization an opportunity to test the Domino installation in an environment similar in nature to the production environment.

Create a list of Domino and Notes features that may be considered mission-critical for your organization. Make sure to test these features thoroughly. For example, your company may want to place all mail files on clustered mail servers to ensure high reliability, failover, and load balancing. List the different types of servers you plan to use -- some companies use Domino only for mail, others use it for messaging, application, Web site hosting, and directory services, among other roles. Test each of these items -- whether a vital application, server configuration, or role under Domino. This lets you accumulate knowledge and create best practices for the deployment of your organization.

Share the knowledge once you have compiled best practices, and communicate them to your install team and to all parts of your organization involved in the installation of Domino. This lets others benefit from your experiences, minimizing effort, mistakes, and duplication, and allowing you to maximize productivity.

As part of this pilot, consider an initial deployment. In larger companies and especially in enterprise organizations, consider a limited-scale deployment to one group or business unit that serves as a model for the rest of the organization. Use this deployment of Domino, along with your pilot project, to test your assumptions, plans and expectations regarding the installation, interoperability, and training on the new software. Choose a group for the deployment that is comfortable with change and learning. Make sure the group is invested in the project by discussing its benefits for them and encouraging them to share their concerns. Support their transition to Domino and capture their experiences and feedback for use in planning your organizational roll out.

Encourage users to share their experiences and feedback about Domino and about the roll out procedure so that you can adapt your plan to avoid problems and leverage strengths.

Think of this initial deployment as a beta release of your install plan. It allows you to test your plan under actual business conditions and to work out any issues before moving to a company wide roll out.

This type of initial, small-scale deployment may not be necessary for smaller companies, who have fewer issues regarding scalability, and for companies who need to install Domino quickly. Even without such a deployment, capture feedback and experiences to evaluate and modify your install strategy as you move through it.

## **5. Document Experiences, Problems, and Solutions From the Pilot Project**

The most important item of the pilot project is the documentation of the administrator's and end users' feedback. It is vital that feedback be gathered from the very beginning all the way through the end of the pilot project. Feedback should be shared by conducting meetings with key players in the pilot project as well as placing it in a discussion database which will serve as a knowledge base of issues and errors and their solutions for future use. You should also document any suggestions you may receive and modify the installation plan when appropriate.

This information is very important to the success of the next phase of the implementation project. It allows you to avoid making the same mistakes twice. The information should be as detailed as possible. It should include the problem, its solution, and any and all steps along the way. This level of detail will be a key factor in smoothing your Domino installation plan and provide a better chance of success and greater end user satisfaction with the overall process.

## **6. Create an Install Plan for the Network Infrastructure**

Planning the network infrastructure is an important part of the Domino Server installation process. With an incorrectly configured network, many unpredictable results can occur. When forming the network infrastructure plan, you should take into consideration some of the following items:

- Existing servers, network hardware, and applications
- Obtaining static TCP/IP addresses
- Domain Name Server (DNS) configuration
- Bandwidth considerations for Local Area Network (LAN) connections
- Bandwidth considerations for Wide Area Network (WAN) connections
- Internet domain name registration and fees
- Internet Service Provider (ISP) registration and service fees
- Routers, switches, and hubs configurations
- Firewall installation and configuration
- Proxy server configuration
- Remote dial in access
- Physical security of the equipment
- Disaster recovery and documentation

Be sure to designate one or more project leaders for this phase of the Domino implementation. These leaders should be responsible for:

- Coordinating the schedule
- Setup and monitor installation or modifications of the network
- Notifying users and management of any network modifications and its effect on them
- Capture knowledge and share it through best practices

- Document issues encountered and their solutions
- Coordinate communication, including project databases, meetings, and conference calls

Set responsibilities and designate who performs which functions and at what times. Ensure that there is a contact person for each role and responsibility -- this person should be one of the members of the install team.

Set procedures by documenting the steps your team will take to implement the network infrastructure plan. Be sure to include troubleshooting information, procedures for backing up systems, ways to notify users when the system will be unavailable, and contact information for questions.

Establish strategy by including capturing data, issues, solutions, and feedback in a database for use as a knowledge repository. This database will be the starting point for creating a set of guidelines, procedures, and knowledge that represents the Domino installation in your organization. By capturing feedback as you progress through your plan, your team can shift its operations, or order of events to better meet the organization's needs.

A well thought out plan should make provisions for disaster recovery. For example, in case a T3 communication line fails due to unforeseen circumstances, there should be a backup T3 or other communication line that provides redundant service until the original line can resume service; thus keeping the network functioning.

## **7. Create or Modify an Existing Disaster Recovery Plan**

We can not stress enough how important it is to have an excellent disaster recovery plan. Disasters can be natural events, mechanical failures, and human errors. The following list contains items that any organization should be prepared for:

- Power outages
- Tornadoes, hurricanes, floods, lightning strikes, and other natural disasters
- Equipment failures such as server hardware, disk drives, network equipment, telephone equipment, and air conditioning
- Users or administrators that accidentally delete files or other types of data
- Users or administrators that may accidentally unplug a server or other vital piece of equipment
- Server crashes
- Out of disk space errors
- Faulty WAN connections such as a T1 or T3 communication line
- Bandwidth degradation
- Viruses
- Sabotage

Each organization's environment is unique and the costs associated with redundancy for some companies can be overwhelming. However, mission critical systems should be a primary concern. Having a single point of failure could be devastating if not crippling to the entire operation of your company. For example, your company implements Domino and uses it for a sales force automation application which is mission critical to the overall operation of the entire organization. You would probably want to make use of multiple database replicas (database copies) to safeguard data and make it accessible across geographic boundaries. You would also want to make use of Domino's server clustering technology to provide high availability and load balancing features to your end users. With this configuration, there is no single point of failure.

A disaster recovery plan should contain complete detailed documentation for every system to include servers, network hardware, applications, telecommunications, and tape backup. Documentation should answer three questions at a minimum:



1. What should be done when a given system fails? For example, when System A fails the solution is to verify that System B came online and took over the responsibilities of System A.
2. Who should be notified? A list of contact telephone numbers should be available. This information should contain office, home, pager, and mobile telephone numbers of the administrator responsible for the equipment that has failed. This contact list should also include supervisor's and manager's names and numbers as well.
3. Are there any follow up instructions or actions that need to be taken, such as calling repair personnel, ordering new replacement equipment, or monitoring other systems that may be affected?

The disaster recovery plan should include complete instructions for conducting complete daily system backups of every system, and the procedure for recovering lost data from the tapes in the event that data needs to be restored.

Viruses should be a major concern. Steps that describe how to monitor virus scans and how to remove them from infected equipment should be included in the disaster recovery plan as well.

Make sure a hard copy of this disaster plan is kept in a safe place. Don't risk a single point of failure by storing the disaster recovery plan on a file server.

## **8. Create an Install Plan for the Server Hardware and Operating System**

Planning how to install the server hardware and operating system is another important part of the Domino Server installation process. This plan will ensure that you have the right sized server with all components configured correctly, including the operating system, before the actual installation of the Domino Server software. When forming the server hardware and operating system plan, you should take the following hardware and operating system items into consideration:

### **Hardware:**

- Sizing requirements for system model, disk, memory, processors, paging space, and network adapters need to be sufficient in order to support the user population.
- Uninterruptible Power Source (UPS) capacity.
- Physical hardware security.
- Spare parts of components that are considered mission critical should be kept on hand in the event of a disaster. These parts could include disk drives, SCSI controllers, fiber optic cables, and internal power units.
- Tape backup.
- Disaster recovery and documentation.

### **Operating System:**

- Domino Server requires specific versions of the operating system be installed. Make sure the operating system version is supported for use with Domino Server.
- Plan and install any system patches that maybe required.
- Plan volume groups, logical volumes, and file systems.
- Plan and set environment variables when applicable.
- Designate operating system administrators.
- Perform a full system backup prior to any installation and after.
- Document your disaster recovery strategy.

Be sure to designate one or more project leaders for this phase of the Domino implementation. These leaders should be responsible for:

- Coordinating the schedule.
- Setup and monitor the installation of the server hardware and operating system.
- Notifying users and management of any issues that may effect them.
- Capture knowledge and share it through best practices.
- Documenting issues encountered (and their solutions).
- Coordinating communication, including project databases, meetings, and conference calls.

Set responsibilities and designate who performs which functions and at what times. Ensure that there is a contact person for each responsibility -- this person should be one of the members of the install team.

Set procedures by documenting the steps your team will take to install the hardware and operating system. Be sure to include troubleshooting information, procedures for backing up key files, ways to notify users that a server will be unavailable, and contact information for questions.

Establish strategy by including capturing data, issues, solutions, and feedback in a database for use as a knowledge repository. This database will be the starting point for creating a set of guidelines, procedures, and knowledge that represents the Domino installation in your organization. By capturing feedback as you progress through your plan, you team can shift its operations, or order of events to better meet the organization's needs.

Again, a good plan should make provisions for disaster recovery for both the hardware and the operating system. Spare parts, operating system installation media, and required system patches should be kept on hand for emergency use.

## **9. Create an Install Plan for the Domino Servers and Notes Workstations**

This plan will provide you with a detailed guide to your Domino Server and workstation environment. When forming the Domino Server and Notes workstation plan, you should take the following server and workstation items into consideration:

### **Server:**

- Hardware and operating system requirements
- Server topology
- Domino server partitioning
- Domino server clustering
- Domino domains and naming conventions
- Server-to-server connections
- Server-to-user connections
- Server-to-Internet connections
- Server function (mail, application, or Web)
- Server protocols (TCP/IP or IPX)
- Mail routing to include Internet mail
- Replication schedule
- Web serving
- Designate Domino System Administrators
- Designate Domino Application Developers, if applicable

- Tape backup
- Disaster recovery and documentation

**Workstation:**

- Hardware and operating system requirements
- User training
- Tape backup
- Disaster recovery and documentation

Be sure to designate one or more project leaders for this phase of the Domino implementation. These leaders should be responsible for:

- Coordinating the schedule
- Setup and monitor the installation of the servers and workstations
- Notifying users and management of any issues that may effect them
- Capturing knowledge and share it through best practices
- Documenting issues encountered and their solutions
- Coordinating communication, including project databases, meetings, and conference calls.

Set responsibilities and designate who performs which functions and at what times. Ensure that there is a contact person for each role and responsibility -- this person should be one of the members of the install team.

Set procedures by documenting the steps your team will take to install servers, clients, and applications. Be sure to include troubleshooting information, procedures for backing up key files, ways to notify users that a server will be unavailable, and contact information for questions.

Establish strategy by including capturing data, issues, solutions, and feedback in a database for use as a knowledge repository. This database will be the starting point for creating a set of guidelines, procedures, and knowledge that represents the Domino installation in your organization. By capturing feedback as you progress through your plan, you team can shift its operations, or order of events to better meet the organization's needs.

Plan for training on how to train uses on the new Notes client interface. While the interface is easy to use, especially for users accustomed to Web browsers, some training may be necessary to make sure the end users understand how to make good use of the Notes client and its features. Training for administrators and help desk personnel should be conducted as well. A well educated staff provides excellent end user support and ensures proper maintenance of the servers.

Examine the hardware and software needs not only on the server equipment, but on the client equipment as well. For example, if your organization has Microsoft Windows 3.1 on its workstations and you are installing Notes R5, each workstation will have to be upgraded to Microsoft Windows 95, 98, or 2000, or Windows NT 4.0.

A good plan should make provisions for disaster recovery for both servers and workstations. Tape backups of data, multiple database replicas (database copies), and contact information should be included.

**10. Schedule and Perform the Installation, Upgrade, or Configuration of the Network Infrastructure**

Schedule the network infrastructure implementation phase after you have completed your testing in the pilot project. Make sure you consider organizational needs, allow time to capture knowledge, identify dependencies, and ensure accountability during this phase.

When scheduling, consider the effect on your organization and solicit input from the representatives on your team and from management for each area or department that will be affected by this phase of the process. Some departments maybe in a period when they are working on time, or mission critical projects and can not be disturbed. Because of this, parts of the project may have to be scheduled after normal business hours.

Be certain to allow sufficient time not only to perform the tasks involved in this part of the project, such as doing system backups, installing equipment and software, checking for problems, and training, but also allow time to record issues encountered, solutions created, and feedback. This initial investment of time results in streamlined procedures and increased satisfaction.

Identify any dependencies in your process and be certain to schedule appropriately. For example, you may need to upgrade a piece of equipment before you can install something else, and you should not move on until this step is complete. Remember that the process of implementation can not begin until the install team is organized and has developed procedures for completing the tasks.

Be sure to create accountability by assigning a person or group the responsibility of each item on the schedule and a date when that item needs to be completed. Allow some flexibility in the schedule and in the due dates to accommodate unexpected issues and the need for learning.

Once the schedule is complete, start implementation. Remember to document problems encountered and their solutions, as well as any other feedback or suggestions. Based on this, make modifications to the procedures where appropriate.

## **11. Schedule and Perform the Installation of the Server Hardware and Operating System**

Schedule the installation of the server hardware and operating system phase next. Make sure you consider organizational needs, allow time to capture knowledge, identify dependencies, and ensure accountability during this phase.

When scheduling, consider the effect on your organization and solicit input from the representatives on your team and from management for each area or department that will be affected by this phase of the process. Some departments maybe in a period when they are working on time, or mission critical projects and can not be disturbed. Because of this, parts of the project may have to be scheduled after normal business hours.

Be certain to allow sufficient time not only to perform the tasks involved in this part of the project, such as doing system backups, installing equipment and software, checking for problems, and training, but also allow time to record issues encountered, solutions created, and feedback. This initial investment of time results in streamlined procedures and increased satisfaction.

Identify any dependencies in your process and be certain to schedule appropriately. For example, you may need to upgrade a piece of hardware before you can install something else, and you should not move on until this step is complete. Remember that the process of implementation can not begin until the install team is organized and has developed procedures for completing the tasks.

Be sure to create accountability by assigning a person or group the responsibility of each item on the schedule and a date when that item needs to be completed. Allow some flexibility in the schedule and in the due dates to accommodate unexpected issues and the need for learning.

Once the schedule is complete, start implementation. Remember to document problems encountered and their solutions, as well as any other feedback or suggestions. Based on this, make modifications to procedures where appropriate.

## **12. Schedule and Perform the Installation of the Domino Servers**

Schedule the installation of the Domino Servers next. Make sure you consider organizational needs, allow time to capture knowledge, identify dependencies, and ensure accountability during this phase.

When scheduling, consider the effect on your organization and solicit input from the representatives on your team and from management for each area or department that will be affected by this phase of the process. Some departments may be in a period when they are working on time, or mission critical

projects and cannot be disturbed. Because of this, parts of the project may have to be scheduled after normal business hours.

Be certain to allow sufficient time not only to perform the tasks involved in this part of the project, such as doing system backups, installing equipment and software, checking for problems, and training, but also allow time to record issues encountered, solutions created, and feedback. This initial investment of time results in streamlined procedures and increased satisfaction.

Identify any dependencies in your process and be certain to schedule appropriately. For example, you may need to upgrade a piece of equipment before you can install something else, and you should not move on until this step is complete. Remember that the process of implementation cannot begin until the install team is organized and has developed procedures for completing the tasks.

Be sure to create accountability by assigning a person or group the responsibility of each item on the schedule and a date when that item needs to be completed. Allow some flexibility in the schedule and in the due dates to accommodate unexpected issues and the need for learning.

Once the schedule is complete, start implementation. You can refer to the Domino Server Installation section in this paper for detailed directions on how to install the software. Remember to document problems encountered and their solutions, as well as any other feedback or suggestions. Based on this, make modifications to procedures where appropriate.

### **13. Train the End Users Prior to the Installation of the Notes Client on the Workstations**

Notes R5 contains extensive features that cover mail, applications, Internet and remote access. Given the large number of features that Notes has, including the new end user interface, end user training is a vital part of the implementation process. Taking the necessary steps up front to ensure your users are knowledgeable about the Notes product will reduce the number of help desk calls, reduce the cost associated with technical support, and increase end user productivity and satisfaction.

End users should understand the basics about Notes. For example, they should understand how to start the Notes interface, compose and send mail, use Web browsing, access Domino applications, create and retrieve bookmarks, use calendaring and scheduling, etc.

A training course for your end users can be created which will provide them with basic knowledge about how to navigate in the Notes client, mail and calendar skills, Web browsing, etc. A half-day course is recommended (3-4 hours).

For advanced or "power users," additional course materials can be created which will cover more advanced topics.

There are a few different options when it comes to education. Education can be conducted using any of the following methods. Each method has its pluses and minuses depending on your particular environment.

- Formal Lotus training
- CBT self study course work
- Customized training from a Business Partner

Remember training saves time, money, and headaches and increases productivity

### **14. Schedule and Perform the Installation of the Notes Client on the Workstations**

Schedule the installation of the Notes client on the workstations next. Make sure you consider organizational needs, allow time to capture knowledge, identify dependencies, and ensure accountability during this phase.

When scheduling, consider the effect on your organization and solicit input from the representatives on your team and from management for each area or department that will be affected by this phase of the process. Some departments may be in a period when they are working on time, or mission critical projects and can not be disturbed. Because of this, parts of the project may have to be scheduled after normal business hours.

Be certain to allow sufficient time not only to perform the tasks involved in this part of the project, such as doing system backups, installing equipment and software, checking for problems, and training, but also allow time to record issues encountered, solutions created, and feedback. This initial investment of time results in streamlined procedures and increased satisfaction.

Identify any dependencies in your process and be certain to schedule appropriately. For example, you may need to upgrade the workstation's operating system before you can install the client, and you should not move on until this step is complete. Remember that the process of implementation can not begin until the install team is organized and has developed procedures for completing the tasks.

Be sure to create accountability by assigning a person or group the responsibility of each item on the schedule and a date when that item needs to be completed. Allow some flexibility in the schedule and in the due dates to accommodate unexpected issues and the need for learning.

Once the schedule is complete, start implementation. Remember to document problems encountered and their solutions, as well as any other feedback or suggestions. Make modifications to procedures where appropriate.

### **15. Document Experiences, Problems, and Solutions**

The most important item of this Domino implementation project is the documentation of the administrator's and end users' feedback. Feedback should be gathered from the very beginning all the way through the end of the project, once or twice a week. It should be shared by conducting meetings with key players in the project and placed in a discussion database which will serve as a knowledge base of issues and errors, and their solutions for future use. Also, document any suggestions you receive and modify the installation plan when appropriate.

This information is very important to the success of the implementation project and allows you to plan so as not to make the same mistakes twice. The information should be as detailed as possible, to include the problem, its solution, and any and all steps along the way. This level of detail will be a key factor in smoothing your Domino installation plan and provide a better chance of success and greater end user satisfaction with the overall process.

### **16. Monitor Servers and Assist Users as Needed**

Once the implementation plan has been completed, it's time to monitor Domino Server usage and assist end users. This can be considered as the "day to day" operations of a Domino environment. Without getting into great detail about Domino Administration, you'll probably want to monitor such things as disk space, disk utilization, network bandwidth (especially over WAN connections), server response time, shared memory segment and semaphore utilization, replication events, user name changes, and Domino logs. Be prepared to help end users with possible error messages that may be encountered while using the Notes client.

Make sure that documentation is maintained to collect problems and their solutions, as well as feedback and suggestions. This feedback adds value to the knowledge base of information already collected for future use in troubleshooting problems. This information should be readily accessible to all administrators and support staff.

### **17. Correct any Potential Performance or Configuration Issues as They Are Identified**

When any problem arises, the administrator should document the issue and identify a solution in a timely manner. Keeping the servers fine-tuned is vital to a healthy Domino environment. Monitoring server performance is a daily job, and should be done faithfully in order to maintain peak performance.

### **18. Follow Up Training for Administrators and End Users as Needed**

As your Domino environment grows and matures, you may find it necessary to conduct additional training for administrators, and new employees. Be prepared to provide this training as needed.

Education can be conducted using any of the following methods. Each method has its pros and cons, depending on your particular environment.

- Formal Lotus training
- CBT self study course work
- Customized training from a Business Partner

## Checklist for Implementation

The checklist provided here is a guide to assist in the installation of Lotus Domino Server. Although this checklist is a good reference point, it may not contain everything since each environment is unique.

<b>TASK</b>	<b>Completed?</b>
1. Select an install team.	
2. Take a complete inventory of server, network, and workstation equipment.	
3. Train Domino and Network Administrators.	
4. Setup a pilot project.	
5. Document experiences, problems, and solutions from the pilot project.	
6. Create an install plan for the network infrastructure.	
7. Create or modify an existing disaster recovery plan to include the Domino Servers, network hardware, server hardware, and tape backup.	
8. Create an install plan for the server hardware and operating system.	
9. Create an install plan for Domino Servers and Notes workstations.	
10. Schedule and perform the installation, upgrade, or configuration of the network infrastructure.	
11. Schedule and perform the installation of server hardware and operating system.	
12. Schedule and perform the installation of the Domino Servers.	
13. Train the end users prior to the installation of the Notes client on the workstations.	
14. Schedule and perform the installation of the Notes client on the workstations.	
15. Document experiences, problems, and solutions.	
16. Monitor servers and assist users as needed.	
17. Correct any potential performance or configuration issues as they are identified.	
18. Follow up training for administrators and end users as needed.	



## Installation Steps

Before installing a Lotus Domino R5 Server, certain software, hardware and system requirements must be met and the AIX environment must be prepared. Step by step instructions are provided here to assist in the correct installation of the Lotus Domino Server software. If you want to see these instructions with screen shots, please refer to the IBM Redbook™ SG24-5138-00 "Lotus Domino R5 on IBM RS/6000: Installation, Customization, and Administration."

### A. Preparing the AIX Environment

Since Domino Server doesn't require a graphical desktop interface (CDE or X-windows) anymore, these instructions assume that you are using a command line prompt interface (green screen) to perform the installation.

#### **Step 1 - Login to AIX as the Root User**

Log in to the AIX system as the root user either from a login prompt or by using the AIX command `su -` at the prompt if you are already logged in as another user.

#### **Step 2 - Check your Default Path Environment Variable**

Check the default path. Make sure that it includes `/usr/sbin`. Use the command `echo $PATH` to display the default path and make changes if necessary in the `/etc/environment` file.

#### **Step 3 - Check PTF Levels of Operating System Filesets**

Check to make sure that the version of AIX being used has the necessary operating system patches installed. Use the command `ls1pp -l <fileset>` to check the current level for a given fileset. A list of these system patches or PTF's can be found at the beginning of this paper. Refer to <http://techsupport.services.ibm.com/rs6000/fixes> for PTF download information.

#### **Step 4 - Configure TCP/IP**

Make sure that TCP/IP is configured correctly. For most systems this is probably already done. If TCP/IP has been configured, please skip to step 5.

You should be familiar with TCP/IP and know the hostname, TCP/IP address, network mask, domain name server (DNS) address, and the default gateway address of the RS/6000 you're working with. If you're not familiar with these terms, or are missing some of the information, please contact your network administrator for assistance.

To setup TCP/IP, use the command `smitty tcpip` and press Enter.

You will be presented with the TCP/IP menu. Select **Minimum Configuration & Startup** and press Enter.

A pop up list will appear. Select the desired network interface adapter from the list and press Enter.

The configuration screen will appear next. Enter the hostname, Internet address (TCP/IP address), network mask, name server (DNS), domain name, and the default gateway address. Press Enter.

If everything worked, you will see a command status screen which will display "Command: OK."

#### **Step 5 - Stop Daemons**

There are some AIX daemons that will interfere with the operation of the Domino Server. Generally, you will find one or more of the following daemons running on your RS/6000 system.

sendmail

httpd

httpd-lite

These daemons must be stopped in order to free up certain network ports that the Domino Server will need. In order to check to see if you have any of these daemons running, use the command `ps -ef | grep <daemon name>`. If the daemons are not running, then please skip to step 6.

The easiest daemon to stop is sendmail. Although the Domino R5 installation will stop this for you, you must still disable the daemon from restarting upon boot. Stop the sendmail daemon by using the command `stopsrc -s sendmail`.

Next disable the sendmail from restarting by using the command `chrtcp -d sendmail`.

To verify that the sendmail daemon has stopped, use the command `ps -ef | grep sendmail`.

The other two daemons httpd and httpd\_lite are stopped using the same methods. The first thing that must be accomplished is to get the process id (PID) of the daemon. To do this, use the command `ps -ef | grep httpd`.

Once the PID is found, stop the daemon using the command `kill -9 <process id>`.

Next, the httpd daemon must be disabled from restarting upon boot by commenting out the appropriate line in the `/etc/inittab` file using `vi`. To do this, use the command `vi /etc/inittab`.

The first screen to appear will be the top of the `/etc/inittab` file. Next, do a search for the httpd daemon line by using the `vi` command `/httpd` and press Enter. This command will appear at the bottom of the screen as you type.

After you press Enter, `vi` will search the `/etc/inittab` file for any line that contains "httpd" and then display that on the screen.

After the search the cursor is located at the beginning of the line that contains the startup information for the httpd daemon. To comment out this line you must insert a colon at the beginning of the line.

To insert the necessary colon, use the `vi` command `i` to enter the insert mode. Make sure the cursor is at the beginning of the line before you enter the insert mode.

Once in the insert mode, type a colon and a space. When you're finished, press Escape twice to leave the insert mode. Once out of the insert mode you will need to save your changes by using the `vi` command `:wq`. Press Enter. The command will appear at the bottom of the screen as you type.

After you press Enter you will be back at the command prompt.

To verify that the httpd daemon has stopped, use the command `ps -ef | grep httpd`.

### **Step 6 - Create AIX Groups**

Create an AIX group called **notes** for use during the Domino Server installation with the command `mkgroup -A notes`.

### **Step 7 - Create AIX Users**

After the AIX group is created, an AIX user called **notes** should be created. This user will be the one that is logged in when the Domino Server is running. To create it, enter the command `mkuser pgrp=notes groups='staff,notes' home='/server1' fsize='-1' notes`.

Assign a password to the new user by using the command `pwdadm <user>`.

### **Step 8 - Create a Volume Group**

Create a volume group for the Domino data directory. Store your data on a separate volume group by itself. This allows for easier backup and recovery or migration to another RS/6000 in case of hardware failure.

To create a new volume group, make sure you have an unused disk installed and use the command `smitty mkvg`.

The SMIT utility displays the screen to create a new volume group. Enter a new volume group name. In our example we will use the preferred name **dominovg**. Also, select the physical volume to use in this new volume group. When this information has been entered, press Enter.

A pop up message will appear asking you to verify that you really want to create a new volume group. Press Enter again to create the volume group. The command status screen will let you know if everything worked.

### **Step 9 - Create a Logical Volume for the Domino Data Directory**

Now that a new volume group has been created, create a logical volume for our Domino data directory. with the command **smitty mklv**.

The SMIT utility then displays the screen to create a new logical volume. Type in the name of the volume group just created in step 8 and press Enter.

Next you will see the configuration screen for a new logical volume. Enter a new logical volume name. In an example, we'll use the preferred name **dominodatalv**. Enter the total number of logical partitions to allocate for this logical volume. The minimum amount of space needed is 200 MB. Since our physical partition size is 4 MB, we specified 50 logical partitions in our example. Next change the position on the physical volume to center. This improves system performance by reducing disk arm movement when accessing data. Also, change the range of the physical volume to maximum. This improves system performance by making sure that the data is spread evenly across all disks in the volume group. When you have completed this screen, press Enter.

The command status screen will let you know if everything worked.

### **Step 10 - Create a Logical Volume for the Domino Binaries**

Create a logical volume for our Domino binaries with the command **smitty mklv**.

The SMIT utility then displays the screen to create a new logical volume. On this screen use the recommended volume group **rootvg** for the new logical volume. Type **rootvg** and press Enter.

Next you will see the configuration screen for our new logical volume. Enter a new logical volume name. In our example we will use the preferred name **dominobinlv**. Enter the total number of logical partitions to allocate for this logical volume. The minimum amount of space needed is 160 MB. Since our physical partition size is 4 MB, we specified 40 logical partitions in our example. Next change the position on the physical volume to the edge. Since the binaries are only executed once at server startup, we place them on the outer most band of the disk. Also, change the range of the physical volume to maximum. This improves system performance by making sure that the data is spread evenly across all disks in the volume group. When you have completed this screen, press Enter.

The command status screen will let you know if everything worked.

### **Step 11 - Create a File System for the Domino Data Directory**

Now that logical volumes are created and ready, we need to create a new journaled file system (JFS) for our Domino data directory. To create the file system, use the command **smitty crjfslv**.

The SMIT utility displays a menu for creating a journaled file system. Select **Add a Large File Enabled Journaled File System** if you want to support files larger than 2 GB, otherwise select **Add a Standard Journaled File System** and press Enter.

You will see the configuration screen for the new file system. Select **dominodatalv** for the logical volume name. The mount point we are going to use in our example will be **/server1**. It is a good idea to name the mount point something which will be descriptive to the server you are installing. Finally, on this screen you need to change the *mount automatically at system restart* to **yes**. After you have finished, press Enter.

The command status screen will let you know if everything worked.

### **Step 12 - Create a File System for the Domino Binaries**

Create a new journaled file system (JFS) for the Domino binaries with the command **smitty crjfs1v**.

The SMIT utility displays a menu for creating a journaled file system. Select **Add a Standard Journaled File System** and press Enter.

You will see the configuration screen for the new file system. Select **dominobin1v** for the logical volume name. The mount point we are going to use in our example will be **/usr/domino**. This mount point is the preferred directory for the Domino binaries. Last on this screen, you need to change the *mount automatically at system restart* to **yes**. After you have finished, press Enter.

The command status screen will let you know if everything worked.

### **Step 13 - Mount the File Systems**

After you create the file systems, you must then mount them. To mount the file systems, use the commands **mount /server1** and **mount /usr/domino**. To verify that the file systems are mounted, use the command **mount** by itself. The mount command will display all file systems that are mounted.

### **Step 14 - Change Ownership of the New File Systems**

In order for the Domino server to run correctly, we must change the ownership of the file systems we created. To change the ownership use the command **chown -R <user>.<group> <file system>**. An example of this would be:

```
chown -R notes.notes /server1
```

```
chown -R notes.notes /usr/domino
```

### **Step 15 - Paging Space**

Make sure that you have enough paging space available in order for the Domino Server to function properly. Please refer to the paging space formulas given earlier to determine the right amount of paging space for your system.

To check the amount of paging space available on your system, use the command **lspv -a**. With this command you will also be able to see the name of the paging space. In our example, the paging space is named **hd6**.

If you need to add additional paging space, specify the additional space needed in physical partitions. To figure out how many physical partitions we will need, first we have to find out how large each of our physical partitions are. To identify the size of each physical partition located on the volume group, use the command **lsvg <volume group>**. Our paging space is located on rootvg, so we would use the command **lsvg rootvg**.

Once you have the size of the physical partition, you can figure out how many additional partitions you will need to increase the paging space to the size required. To add to the paging space, use the command **chps -s<additional partitions> <paging space name>**. An example of this command would be:

```
chps -s10 hd6
```

To verify that the change to the paging space has taken place, use the command **lspv -a**.

### **Step 16 - Check AIX Kernel Configuration**

We also need to check the AIX kernel configuration for the maximum number of processes allowed per user, and the maximum number of fixed licenses.

To check the current setting for the maximum number of processes allowed per user (maxuproc), use the command **lsattr -El sys0 | grep maxuproc** to display the value. This value must be a minimum of 128 or more. To change the value, use the command **chdev -l sys0 -a maxuproc=<value>**. An example of this command would be:

```
chdev -l sys0 -a maxuproc=128
```

To check the current setting for the maximum number of fixed licenses, use the command `lslicense`. This value must be a minimum of 2 or more in order for the Domino server to function properly. To change the value, use the command `chlicense -u <value>`. An example of this command would be:

```
chlicense -u 2
```

### **Step 17 - Mounting the CDROM**

The final step in preparing the AIX environment is to mount the CDROM that contains the Lotus Domino Server install program. First we have to make sure that a directory exists as a mount point. On our system we will use `/cdrom` for the mount point. If you don't have a directory to use as a mount point such as `/cdrom`, you must create a directory using the `mkdir /<directory>` command.

Once a directory has been created for use as a mount point, we can then mount the CDROM. Before you continue, you should take your Lotus Domino CD and insert it into the CDROM drive at this time.

You will also need to know the name of the CDROM device. In most cases this will be `cd0`, but if you're not sure, or if you'd like to double check, use the command `lsdev -C -c cdrom`. The name of the CDROM drive will be in the first column.

With the CD in the CDROM drive, mount the drive using the command `mount -r -v cdrfs /dev/<device name> /<mount point>`. An example of this would be:

```
mount -r -v cdrfs /dev/cd0 /cdrom
```

You will receive no confirmation that the CDROM has mounted, but you can verify by changing directories to the mount point and do a directory listing.

## **B. Installing the Lotus Domino Server**

Installing the Lotus Domino Server is a two part process. The first part is to install the software from the CD, and the second part is the basic configuration of the server. We will walk through the complete installation step-by-step.

### **Step 1 - Login to AIX as the Root User**

Log in to the AIX system as the root user either from a login prompt or by using the AIX command `su -` at the prompt if you are already logged in as another user.

### **Step 2 - Run the Install Program From the CD**

To start the install program you need to change to the directory `/cdrom/ibmpow` and start the install program by typing `./install` at the command prompt and press Enter.

```
cd /cdrom/ibmpow
```

```
./install
```

### **Step 3 - Welcome Screen**

The welcome screen is displayed. Press the Tab key to continue.

### **Step 4 - License Agreement Screens**

The License agreement screens are displayed. Press the Tab key to continue through each of them.

### **Step 5 - Select the Type of Domino Server to Install**

The next screen asks you which of the different types of Lotus Domino Servers you want to install. The default answer is Domino Mail Server. Press the Spacebar until you see the server type you want to install. Press the Tab key to continue.

### **Step 6 - Select the Directory Location for the Domino Binaries**

On the next screen, select the directory location for the Domino binaries. The default directory is `/opt/lotus`. Change this to `/usr/domino`. To edit the directory press Enter, type the new directory name, `/usr/domino`, and press Enter again. You will notice that the install program will append 'lotus' to the end of the directory automatically. Press the Tab key to continue.

### **Step 7 - Setup for Partitioned Domino Servers**

This next screen asks if you want to install multiple instances, or partitioned servers on this RS/6000. The default answer is no. In our example we will only install one Domino Server. Press the Tab key to continue.

### **Step 8 - Select the Directory Location for the Domino Data**

On the next screen, select the directory location for the Domino data. The default directory is `/local/notesdata`. Change this to `/server1`. To edit the directory, press Enter, type the new directory name, `/server1`, and press Enter again. Press the Tab key to continue.

### **Step 9 - Select AIX User**

Select the appropriate AIX user. The default is `notes`, which in this case is the correct user. Press the Tab key to continue.

### **Step 10 - Select AIX Group**

Next select the appropriate AIX group. The default is `notes`, which in this case is the correct group. Press the Tab key to continue.

### **Step 11 - Configuration Review**

The next screen tells you that you have finished the configuration of the install program and that you are about to review the information you have entered. Press the Tab key to continue.

The installation settings and configurations are displayed. If everything is correct, press the Tab key to start the installation.

### **Step 12 - File Installation Complete**

You will receive a message "Installation successful" if everything worked correctly.

### **Step 13 - Logoff**

You must completely log off the system before starting the next step which begins the configuration. Running the Domino Server with a different user other than the one we specified in step 9 is not a supported configuration.

To log off, simply type `exit` and press Enter. Repeat until you return to the login prompt.

### **Step 14 - Login**

Log in as the user we specified in step 9.

### **Step 15 - Change to the Data Directory**

When you log in, you should already be in the Domino data directory. You can display the current directory you are in by using the `pwd` command. If you're in the wrong directory, use the command `cd/<data directory>` and press Enter. An example of this command would be:

```
cd /server1
```

This can be done from the *.profile* file for Notes users. In addition, you would need to update *.profile* with binary and data directories in the PATH variable.

### **Step 16 - Start the HTTP Server Task For Server Configuration**

We will start the Domino HTTP task so we can configure the new Domino Server with our Web browser. To start the HTTP task, type `/opt/lotus/bin/http httpsetup` at the prompt and press Enter. If the command executes correctly, the screen will display "HTTP Web Server Started." (With a properly configured *.profile*, you only need to enter `http httpsetup`.)

### **Step 17 - Start the Web Browser**

You should start your Web browser now; either Netscape or Internet Explorer. The Web browser can be located on any machine. You do not have to install a Web browser on your RS/6000 to configure your Domino Server. Point the Web browser to `http://<IP address of the RS/6000>:8081/`. An example of this URL would be:

`http://9.3.240.6:8081/`

### **Step 18 - Create a New Domino Server**

You will see the first screen of the Domino Server configuration on your Web browser. It's asking if this is the first server, or if you are adding an additional server to an existing domain. In our example, this will be our first server. Make sure that **First Domino Server** is selected and press the **Next** button.

### **Step 19 - Server Audience**

On the second screen, it is asking if any additional services need to be installed. The default choices are **Calendar Connector, Schedule Manager, Event Manager, and Statistics**. In our example we are going to leave the default choices and press the **Next** button.

### **Step 20 - Administration Settings**

On the third screen specify the administrative information for the Domino Server. This includes organization name, domain name, certifier name, server name, and the administrator's name. In our example, the organization, domain, and certifier names are **ibm**. The country code is **us**. The server name is **server1**. Our administrator's name is **Domino Admin**. After entering this information, press the **Next** button.

### **Step 21 - Network and Communication Settings**

On the fourth screen we will configure the network ports. By default the **Use all available ports** option is selected. Since we only have one port, we're going to leave the default selected and click on the **Finish** button.

### **Step 22 - Server Setup is Complete!**

The server setup is complete. The fifth and final screen displays the configuration and password information we gave in the above steps. After you have read the screen, click on the **Exit** button. If you forget to click the Exit button, the setup will not complete properly.

### **Step 23 - Starting the Domino Server**

To start the Domino Server, make sure you are in the server data directory. In our example, this would be `/server1`. From that directory use the command `/opt/lotus/bin/server`. (If *.profile* is properly configured, you only need to enter `server`.)

The server will start.

Remember that you must start the Domino Server while logged in as the user specified in step 9. Using any other user including the root user, is an unsupported configuration and may cause unpredictable results.

## Post-installation Support

### A. Domino Product Support

IBM provides the technical post installation support for Lotus Domino and related software. Several fee offerings are available and recommended based on the specifics of the customer. Overall, support and upgrade protection is offered under a program called Passport Advantage.

Passport Advantage customer support makes it easy for customers to put IBM and Lotus software support to work in a cost-effective and efficient way. Passport Advantage Customer Support provides easy to access, responsive, cross-platform software support from Lotus -- around the clock and around the world. It is simple for customers to purchase and administer as part of their overall software acquisition. Customers are able to acquire software solutions in one planning and budgeting cycle, with the ease of a single agreement. Lotus integrated support solutions are designed for each Passport Advantage option and tailored to individual customer needs and how they acquire software licenses and subscription. With the Volume Purchase Option, support is acquired as it is needed in incremental incident based packs. With the Contract Option, annual support is selected on a product by product basis, bundled with the software license and Software Subscription. With the Complete Enterprise Option, annual support is included in the per user price for each product category.

Through the convenience and ease of calling the IBM or Lotus number assigned to each customer's calling area, customers receive prompt responses to their questions. Customers can choose the type of support that best meets their business software requirements. They can select from support Monday through Friday during their country business hours or around the clock, seven days a week.

The Volume Purchase Option for support of IBM and Lotus software is a non-contract offering based on the requirements of the customer interested in minimal cost and paperwork. The offering can include:

- 10, 20 and 30 incident packs are available for Notes/Domino
- 5 Incident Pack of 24 x 7 coverage available
- Site Support available for Notes/Domino and 10 Incident Packs available for
- Developer tools
- Per call or per year
- (Acquisitions of IBM support do not earn points under Passport Advantage)

The Contract Option for support is a contract for two years based on points and includes:

- Annual support selected on a product-by-product basis
- May be acquired separately or combined with software and Software Subscription acquisition and renewal
- Single agreement for software programs and support
- Telephone and electronic access (where available) to IBM and Lotus support centers during country business hours
- 24 x 7 support can be acquired for designated callers
- Additional designated callers available for a fee

The Complete Enterprise Option for support is a contract for two years based on "bundles of IBM and Lotus software" and users and includes:

- Annual support is included for all IBM and Lotus products selected
- Single contract for software programs and support
- Telephone and electronic access to IBM and Lotus support centers during country business hours
- 24 x 7 support can be acquired for designated callers



- Additional designated callers available for a fee

More information about Passport Advantage support is available if you are partnering with a Lotus Business Partner through that Business Partner. Or you may contact URL <http://www.lotus.com/home.nsf/welcome/support>.

Customers will most likely also need to obtain Lotus quarterly upgrades and releases as they occur. This is supported under a program called Subscriptions by Lotus. It is a logical part of Passport advantage but can be purchased separately if the VPO is the support model. If the VPO model also proves too expensive for the customer, new releases for upgrade are purchased at the shrink wrap price.

## B. AIX Support

AIX support is provided by IBM Support Family. It is a fee offering and is available to both the end-user customer or the Business Partner. Support Line is the name usually applied to the support and both access and registration can be made by calling in North America 1-800-CALL AIX (1-800-225-5249). Support Line is the service offering through which IBM delivers telephone and electronic support for installation, usage, and code-related questions for the AIX platform and all its installed software. RS/6000 Support Line covers operational questions in support of all IBM RISC System/6000 systems including desktop workstations, workgroup servers, enterprise servers like the pSeries 680 and large scale servers like the SP system. The operational support services provide:

- Normal business hour support
- 24x7 support including holidays
- Full telephone or electronic services

AIX is included with each RS/6000 system in the system price. However, as new releases of AIX are made available, they must be purchased as an upgrade. RS/6000 has various options to purchase the AIX upgrades based on economic consideration of the customer. For more information on support for RS/6000 solutions, go to <http://techsupport.services.ibm.com/rs6000/support>.

## C. Hardware Support

Hardware support of the RS/6000 system must be registered. In North America, the number for hardware support is 1-800-IBM-SERV (1-800-426-7378). For more information on support for RS/6000 solutions, go to <http://www.rs6000.ibm.com/support>. Hardware support can be provided in a variety of ways up to 7x24x365 with 4-hour response time on site.

## Services Available

IBM provides a set of services to assist both Business Partners and customers to implement Domino solutions. These services can also be marketed and sold by Business Partners. For more details, go to <http://www.as.ibm.com/asww>.

Service	Description	Contact
IBM Smoothstart™ Services for AIX HACMP	This service offering implements HACMP for customer based on customer requirements.	IBM PSS sales rep
IBM Smoothstart Services to Enterprise Server	This offering implements RS/6000 servers based on customer requirements.	IBM PSS sales rep
IBM Smoothstart Services for Lotus Domino on RS/6000	This offering implements Lotus Domino on RS6000 based on customer requirements.	IBM PSS sales rep

## Additional Technical Resources

### URLs:

IBM pSeries Web Site

<http://www-1.ibm.com/servers/eserver/pseries>

IBM AIX PTF Information

<http://techsupport.services.ibm.com/rs6000/fixes>

IBM RS/6000 Support

<http://techsupport.services.ibm.com/rs6000/support>

IBM Services for RS/6000 and Domino

<http://www.as.ibm.com/asww>

Lotus Domino Information

<http://www.lotus.com/r5>

Domino Support

<http://www.lotus.com/home.nsf/welcome/support>

Lotus Domino Documentation

<http://www.notes.net/notesus.nsf>

Lotus Domino Performance Web Site

<http://www.lotus.com/performance>

Lotus Domino NotesBench

<http://www.notesbench.org>

<http://www.ideasinternational.com>

### Redbooks:

Lotus Domino R5 on IBM RS/6000: Installation, Customization, and Administration

IBM Redbook SG24-5138-00

International Technical Support Organization, IBM Corporation

Using ADSM to Back Up Lotus Notes

IBM Redbook SG24-4534

International Technical Support Organization, IBM Corporation

RS/6000 Performance Tools in Focus

IBM Redbook SG24-4989

International Technical Support Organization, IBM Corporation

Understanding LDAP

IBM Redbook SG24-4986

International Technical Support Organization, IBM Corporation

LDAP Implementation Cookbook

SG24-5110

International Technical Support Organization, IBM Corporation

RS/6000 SP Monitoring: Keeping It Alive  
IBM Redbook SG24-4873  
International Technical Support Organization, IBM Corporation

Inside the RS/6000 SP  
IBM Redbook SG24-5145  
International Technical Support Organization, IBM Corporation

RS/6000 SP High Availability Infrastructure  
IBM Redbook SG24-4838  
International Technical Support Organization, IBM Corporation

High Availability on the RISC System/6000 Family  
IBM Redbook SG24-4551  
International Technical Support Organization, IBM Corporation

RS/6000 Models E30, F40, F50, and H50 Handbook  
IBM Redbook SG24-5143  
International Technical Support Organization, IBM Corporation

High Availability and Scalability with Domino Clustering and Partitioning on AIX  
IBM Redbook SG24-5163  
International Technical Support Organization, IBM Corporation

Implementing High Availability on RISC/6000 SP  
IBM Redbook SG24-4742  
International Technical Support Organization, IBM Corporation

**Publications:**

Lotus Domino R5 Release Notes Database  
Lotus Corporation

Lotus Domino R5 Administration Help Database  
Lotus Corporation

Resource Tuning of Lotus Domino on AIX: Quick Reference Guide  
IBM Lotus Integration Center (ILIC) AIX Team

## Appendix A. Sample Configurator Configurations

The information shown here does not necessarily constitute a complete or valid order. Prices are in US dollars.

### A. Small Configuration

The configuration is an IBM pSeries 640 with 4 POWER3-II 375 MHz processors, 8 GB memory, and 64 18.2 GB drives for data.

***** HARDWARE *****				
Product	Description	Qty	Purchase	Maint
7026-B80	pSeries 640	1	5649	140 F
	Integrated Internal Ultra2 SCSI Port	1	N/C	
	Integrated External Ultra2 SCSI Port	1	N/C	
	Integrated Ethernet Adapter	2	N/C	
2624	32x Speed CD-ROM	1	375	
2830	POWER GXT130P Graphics Adapter (PCI)	1	340	
3025	9.1 GB 10K RPM 1" Ultra2 SCSI 16-bit Disk	2	2520	
3627	P76 Color Monitor, Stealth Black	1	995	
3752	Service Package	1	75	
4098	Memory Expansion Feature	1	1038	
4121	1024 MB (2x512MB) SDRAM DIMMs	8	49152	
4362	2-way 375MHz POWER3-II Processor Card	2	26000	140 F
5005	Preinstall	1	N/C	
6230	Advanced SerialRAID Plus Adapter	1	3000	
8700	Quiet Touch Keyboard, Stealth Black - English (US)	1	100	
8741	3-Button Mouse - Stealth Black	1	75	
9172	AC Power Specify	1	N/C	
9300	Language - English (US)	1	N/C	
9800	Power Cord - US/Canada	1	N/C	
9911	Rack Power Cord - ALL IBM Racks, 4m	1	N/C	
			=====	=====
7026-B80 Price			89319	
Monthly Maintenance				280

7133-D40 Advanced SSA Disk Subsystem (Rack-Mounted)	4	51000	736 F
0987 Rochester Integration	4	N/C	
8022 50/60Hz AC, 300 VDC Power Supplies	4	8000	
8031 Raven Black Drawer Cover	4	1000	
8518 One 10K/18.2GB Advanced Disk Drive Module	64	288000	
9300 Language - English (US)	4	N/C	
		=====	=====
7133-D40 Price		348000	
Monthly Maintenance			736

9910-A30 APC 5000VA Smart-UPS Rack-Mount	1	3955	
SmartSlot 4x4 10BaseT SNMP Adapter (Standard)	1	N/C	
		=====	
9910-A30 Price		3955	

\*\*\*\*\* SOFTWARE \*\*\*\*\*

Product	Description	Qty	License
5765-C34 AIX Version 4		1	N/C
4061 AIX 4.3		1	N/C
5005 Preinstall		1	N/C
9001 Asset Registration		1	N/C
			=====
5765-C34 OTC			0
5692-AIX System Software		1	N/C
0598 AIX Welcome Center		1	N/C
0838 AIX 4.3 Update CD		1	N/C
0857 AIX 4.3		1	N/C
0859 Preinstall AIX 4.3 Server Bundle		1	N/C
0860 AIX 4.3 Bonus Pack - Non Export.		1	N/C
1004 CD-ROM Process Charge		1	50
2924 English		1	N/C
3410 CD-ROM		1	N/C

5005 Preinstall	1	N/C	
5924 AIX 4.3 PII - English	1	N/C	
9001 Asset Registration	1	N/C	
		=====	
5692-AIX OTC		50	
Lotus Domino Server	1	5000	
***** GRAND TOTALS *****			
Hardware Price		441274	
Software OTC		5050	
		=====	
Grand Total		446324	
Monthly Maintenance			1016

## B. Medium Configuration

The configuration is an IBM RS/6000 Enterprise Server Model M80 with 8 RS64-III 500 MHz processors, 16 GB memory, and 96 18.2 GB drives for data.

***** HARDWARE *****				
Product	Description	Qty	Purchase	Maint
7026-M80	RS/6000 Enterprise Server Model M80	1	3093	365 F
	1.44MB 3.5-in Diskette Drive	1	N/C	
	Integrated SCSI-2 F/W Adapter	1	N/C	
	Integrated Ultra2 SCSI Adapter	1	N/C	
	Integrated Ethernet Adapter	1	N/C	
2624	32x Speed CD-ROM	1	375	
2830	POWER GXT130P Graphics Adapter (PCI)	1	340	
2968	10/100 Mbps Ethernet PCI Adapter	1	275	
3027	9.1 GB 10K RPM Ultra SCSI Disk Drive	2	2320	
3142	Remote I/O Cable - 3m	2	1190	
3627	P76 Color Monitor, Stealth Black	1	995	
4073	Memory Board, 32-position	2	3000	
4135	4096 MB Memory (8x512MB DIMMs)	2	73728	

5005 Preinstall	1	N/C	
5203 4-Way RS64 III 500MHz Processor Card, 4MB L2 Cache	2	148000	840 F
5992 System Control and Initialization Cable	1	75	
6132 CEC to Primary I/O Drawer Power Control Cable, 3m	1	95	
6197 190A Processor Power Regulator	1	4000	
6230 Advanced SerialRAID Plus Adapter	1	3000	
6283 Redundant AC Power Supply, I/O Drawer, 595W	1	725	
6284 Redundant AC Power Supply, CEC, 1100W	1	750	
6324 Primary I/O Drawer, 5 EIA	1	8000	
6540 IPL Disk Mounting Hardware, Cables, Terminator	1	100	
8700 Quiet Touch Keyboard, Stealth Black - English (US)	1	100	
8741 3-Button Mouse - Stealth Black	1	75	
9172 AC Power Specify	1	N/C	
9300 Language - English (US)	1	N/C	
9800 Power Cord - US/Canada	1	N/C	
		=====	=====
7026-M80 Price		250236	
Monthly Maintenance			1205
7133-D40 Advanced SSA Disk Subsystem (Rack-Mounted)	6	76500	1104 F
0987 Rochester Integration	6	N/C	
8022 50/60Hz AC, 300 VDC Power Supplies	6	12000	
8031 Raven Black Drawer Cover	6	1500	
8518 One 10K/18.2GB Advanced Disk Drive Module	96	432000	
9300 Language - English (US)	6	N/C	
		=====	=====
7133-D40 Price		522000	
Monthly Maintenance			1104
9910-A30 APC 5000VA Smart-UPS Rack-Mount SmartSlot 4x4 10BaseT SNMP Adapter (Standard)	1 1	3955 N/C	
		=====	
9910-A30 Price		3955	



\*\*\*\*\* SOFTWARE \*\*\*\*\*

Product	Description	Qty	License
5765-C34	AIX Version 4	1	N/C
4061	AIX 4.3	1	N/C
5005	Preinstall	1	N/C
9001	Asset Registration	1	N/C
			=====
	5765-C34 OTC		0
5692-AIX	System Software	1	N/C
0598	AIX Welcome Center	1	N/C
0838	AIX 4.3 Update CD	1	N/C
0857	AIX 4.3	1	N/C
0859	Preinstall AIX 4.3 Server	1	N/C
	Bundle		
0860	AIX 4.3 Bonus Pack - Non	1	N/C
	Export.		
1004	CD-ROM Process Charge	1	50
2924	English	1	N/C
3410	CD-ROM	1	N/C
5005	Preinstall	1	N/C
5924	AIX 4.3 PII - English	1	N/C
9001	Asset Registration	1	N/C
			=====
	5692-AIX OTC		50
Lotus Domino Server		1	5000

\*\*\*\*\* GRAND TOTALS \*\*\*\*\*

Hardware Price	776191	
Software OTC	5050	
	=====	
Grand Total	781241	
Monthly Maintenance		2309

## C. Large Configuration

The configuration is an IBM pSeries 680 with 24 RS64-IV 600 MHz processors, 96 GB memory, and 288 18.2 GB drives for data.

\*\*\*\*\* HARDWARE \*\*\*\*\*

Product	Description	Qty	Purchase	Maint
7017-S85	pSeries 680	1	11188	941 F
	1.44MB 3.5-in Diskette Drive	1	N/C	
	One RIO Loop	1	N/C	
2447	16-Bit PCI SCSI SE Adapter to 6	1	75	
	SCSI Bays Cable			
2624	32x Speed CD-ROM Drive	1	375	
2968	10/100 Mbps Ethernet PCI	9	2475	
	Adapter			
3002	9.1 GB 10K RPM 1" Ultra SCSI	1	1260	
	Hot Swap Disk Drive			
3143	Remote I/O Cable - 6m	3	2235	
4195	32768 MB Memory (4x8192MB	3	884736	
	Cards)			
5005	Preinstall	1	N/C	
5320	6-way 600 MHz RS64 IV Processor	1	230000	2324 F
	Card, 16MB L2 Cache			
5321	6-way 600MHz RS64 IV Processor	3	750000	6972 F
	Card, 16MB L2 Cache			
6000	System Control and	1	400	
	Initialization Cable			
6008	Processor Complex to Rack Power	3	135	
	Control Cable			
6088	Front Door for 1.8m Rack, Black	1	450	
	with Copper			
6098	Side Panel for 1.8 or 2.0m	2	300	
	Rack, Black			
6193	1000 Watt AC Power Supply	1	765	
6194	Programmable Power Regulator	1	380	
6195	Processor Power Regulator	1	2125	
6206	Ultra SCSI PCI-Bus Adapter	2	790	
6230	Advanced SerialRAID Plus	9	27000	
	Adapter			
6235	32 MB Fast-Write Cache Option	9	5175	
	Card			
6320	SCSI I/O Drawer, 10 EIA	2	47532	
6321	Primary I/O Drawer Group	1	600	

6323 Secondary I/O Drawer Group	1	734		
6326 Support Processor Group	1	2700		
6503 Remote I/O Hub, Dual Loop	1	8000		
6547 SCSI 6-pack Hot Swap Back Plane	1	600		
7036 36U I/O Rack	1	3100	32	F
9171 Power Distribution Unit, Side-Mount , 1 Phase	1	N/C		
9300 Language - English (US)	1	N/C		
9800 Power Cord - US/Canada	1	N/C		
		=====	=====	
7017-S85 Price		1983130		
Monthly Maintenance			10269	
7014-T00 Enterprise Rack - 36 EIA	1	3100	32	F
6088 Front Door for 1.8m Rack, Black	1	450		
6098 Side Panel for 1.8 or 2.0m Rack, Black	2	300		
9171 Power Distribution Unit, Side-Mount, 1 Phase	1	N/C		
9300 Language - English (US)	1	N/C		
9800 Rack Power Cord - US/Canada	1	N/C		
		=====	=====	
7014-T00 Price		3850		
Monthly Maintenance			32	
7133-D40 Advanced SSA Disk Subsystem (Rack-Mounted)	18	229500	3312	F
0987 Rochester Integration	18	N/C		
8022 50/60Hz AC, 300 VDC Power Supplies	18	36000		
8031 Raven Black Drawer Cover	18	4500		
8518 One 10K/18.2GB Advanced Disk Drive Module	288	1296000		
9300 Language - English (US)	18	N/C		
		=====	=====	
7133-D40 Price		1566000		
Monthly Maintenance			3312	
9910-EP8 Prestige 6000VA, 208-240V, 50/60Hz	1	6625		
6555 Power Pass Distribution Module (120/208V)	1	N/C		

9001 Onlinet Network for AIX, RS-232 Cable	1	N/C
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9910-EP8 Price	6625
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\*\*\*\*\* SOFTWARE \*\*\*\*\*

Product	Description	Qty	License
5765-C34	AIX Version 4	1	N/C
4061	AIX 4.3	1	N/C
5005	Preinstall	1	N/C
9001	Asset Registration	1	N/C

5765-C34 OTC	0
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5692-AIX	System Software	1	N/C
0598	AIX Welcome Center	1	N/C
0838	AIX 4.3 Update CD	1	N/C
0857	AIX 4.3	1	N/C
0859	Preinstall AIX 4.3 Server Bundle	1	N/C
0860	AIX 4.3 Bonus Pack - Non Export.	1	N/C
1004	CD-ROM Process Charge	1	50
2924	English	1	N/C
3410	CD-ROM	1	N/C
5005	Preinstall	1	N/C
5924	AIX 4.3 PII - English	1	N/C
9001	Asset Registration	1	N/C

5692-AIX OTC	50
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Lotus Domino Server	1	5000
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\*\*\*\*\* GRAND TOTALS \*\*\*\*\*

Hardware Price	3564605
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Software OTC	50
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Grand Total	3564655
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Monthly Maintenance	13613
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## Appendix B. IBM Production Configuration

The vast majority of Domino servers in the IBM deployment run on the AIX platform today. Managed by IBM Global Services, this is the largest Domino deployment in the world with over 1900 R5 mail and application servers supporting more than 300,000 production Notes and Web users. IBM is currently upgrading both hardware and software technology in this testimonial to Domino for AIX in a very large enterprise environment -- one that demands high performance, mission-critical availability, and scalability for both users and data.

One production scenario is a mixed RS/6000 M80-SP environment in Boulder, Colorado. Central to the configuration is an 8-way 7026-M80 server attached to an ESS F20 (3.2 TB) Storage Area Network (SAN), with an Ethernet connection to the network. The ESS storage is used for Domino transaction logging, as well as user data. The largest Domino database housed on the M80 server is the 2 GB Domino Directory due to the large number of IBM employees.

The M80 currently supports a population of 5,200 registered Lotus Notes users split across two Domino server partitions. Each of the partitions is clustered with two Silver node servers for failover support. Approximately one third of the users are concurrently active at any given time during business hours. Prime shift workload represents 5.3 million transactions with 75% CPU utilization and consistently sub-second response time. ESS disk activity is 40 to 45%. Such results have enabled IBM to consolidate servers and achieve roughly a 5-fold reduction in server requirements.

As of June 2001, the M80 server configuration is as follows:

- Eight (8) RS64 III processors running at 500 MHz, with 4 GB level 2 cache
- 16 GB of memory
- Ten (10) 18.2 GB Ultra SCSI (currently only two are in use for rootvg)
- Two (2) 32-bit fibre channel adapters to SAN
- One (1) Gigabit Ethernet adapters to network
- ESS F20 (3.2 TB) SAN (only half currently allocated)
- AIX 4.3.3.50
- Domino 5.0.6

The memory configuration represents more capacity than required to support the user workload at the response time and resource utilization we have witnessed. This is true even with clustering enabled, which requires non-trivial overhead.

Each Domino partition is allocated 4 GB of memory, totaling half of the physical memory available to the system. There is no paging taking place on the server and no evidence of any memory-related bottlenecks or issues. The implementation does not include any form of processor binding, so there is no set affinity for process to processor. Therefore, all eight processors are available to any Domino task.

Development lab testing has shown potential performance and scalability improvements of an option known as Hardware MultiThreading (HMT). Very recently, IBM Global Services installed maintenance level 8 (APAR IY10778) and microcode update MM1032 needed to enable HMT on the M80 server in Boulder. HMT allows each physical processor to appear to an application as two virtual processors running at half speed. Thus, the M80 server appears to Domino as having sixteen (16) 250 MHz processors, as opposed to the actual eight (8) 500 MHz processors.

The benefits of HMT depend upon the characteristics of the application. The use of more (virtual) processors can allow overlapping of memory access. This optimizes the use of fast processors due to less time spent waiting for memory, and more time spent on execution of commands. Thus, HMT has the potential to double processor workload, and still achieve a performance improvement due to the more efficient use of slower resources such as memory. In the IBM environment with Domino for AIX 5.0.6, the result to date is an approximate 20% reduction in the 75% processor busy metric reported above. This

represents an opportunity for increased user workload and scalability with the same configuration. Only time will tell.